EG&G ROCKY FLATS

000013696

INTEROFFICE CORRESPONDENCE

DATE November 11, 1993

TO E C Mast, Environmental Restoration, Bldg 080, X8589

FROM H A Wolaver, Surface Water Division, Bldg T893A, X5699

SUBJECT SUMMARY OF RESULTS FOR OU6 WATER AND SEDIMENT TOXICITY TEST RESULTS - HAW-011-93

The Surface Water Division and Environmental Technologies have completed a draft summary report for Operable Unit 6 (OU6) and sediment toxicity test results (see attachment) The draft report is adaptable to any further sampling events, but is also written to be included in its entirety

Water toxicity tests for the pond and drainage sampling sites resulted in acute toxicity for three locations Ponds B-3, B-4, and B-5 samples contained unionized ammonia concentrations at toxic levels One pond resulted in measurable sediment toxicity Pond B-2 sediments were toxic to one organism lowering the survival rate

If you have any questions, or desire more information please call me at the extension listed above or D3136

fm

Attachment
As Stated

cc
C E Baldwin
S A Marshall
S D Spence

DOCUMENT CLASSIFICATION WAIVER PER CLASSIFICATION OFFICE

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INTRODUCTION

An important objective of the OU6 characterization is to use an integrated strategy in defining water quality The EPA authorizes an integrated approach that involves the measurement of water and sediment chemical make-up, whole effluent toxicity (WET), and biological conditions When the WET and biological monitoring approaches are used, it is possible to gain a better understanding of the additive effects that the water chemistry has on downstream aquatic systems and users

The OU6 characterization included water and sediment toxicity tests on all OU6 ponds to measure possible contaminant effects on aquatic and benthic organisms This section will report the toxicity results and discuss the points of interest

METHODS

Sampling Locations

RFP has performed water toxicity tests from 1989 to present for NPDES permit outfalls (Sewage Treatment Plant (STP), B-5 influent to A-4, A-4 Discharge, and C-2 Discharge) and other ponds in question Within OU6, there is historic WET data for the STP effluent, B-5, A-3, and A-4 Ponds To avoid redundancy, the ponds that have not shown a history of water toxicity results were not re-tested Those excluded from water toxicity tests for this characterization include A-3 and A-4 Ponds

The locations tested for water toxicity are shown in Table 1 In addition to the ponds, DOE-RFO, EG&G, USEPA, and CDH selected sampling locations in Walnut Creek upstream from the ponds and at positions immediately downstream from significant tributaries (Figure 1) These additional locations were to be sampled during base flow and storm flow conditions

There is no historic sediment toxicity testing in OU6 All of the OU6 ponds were chosen as areas of interest for sediment toxicity testing due to their downstream location from RFP and sediment loading (Table 1 and Figure 1)

Water and sediment toxicity samples were taken as split samples with chemical analyses for all locations excluding control samples

Laboratory Methods

There were two levels of water toxicity testing applied to the OU6 characterization the WET screen and WET dilution series

The WET screen is an inexpensive test used first to determine whether toxicity exists The test is simplified with four replicates and a control In each replicate, five organisms were tested in a non-diluted water sample The control is made up of reconstituted water The SeaCrest Group performed the 48-hour tests using *Ceriodaphnia dubia* (water flea) and the 96-hour test using *Pimephales promelas* (fathead minnow) If there was no toxicity for the WET screen, no further testing was necessary If toxicity existed, a second sample was taken and tested in a WET dilution series

For the WET dilutions, water samples were subjected to acute replacement static toxicity tests conducted in conformity with "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" USEPA 600/4-90 027 and the Region VIII USEPA "NPDES Acute Test Conditions - Static Renewal Whole Effluent Toxicity " The WET dilution series is made up of four replicates for a 100% sample, and four replicates each for samples diluted to 75%, 50%, 25%, and 12% of the sample water Five organisms are tested in

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Table 1 OU6 sampling locations for water and sediment toxicity testing

Location	Water	Sediment (2)	
	Ceriodaphnia/Pimephales (1)	*Hyalella*	*Chironomus (3)*
A 1	X	X	NTO
A 2	X	X	NTO
A 3	NA	X	X
A 4	NA	X	X
A 5 (Walnut Creek at Indiana)	NA	X	NTO
B 1	X	X	NTO
B 2	X	X	NTO
B 3	X	X	X
B 4	X	X	X
B 5	X	X	X
SW116	X	NA	NA
SW118	X	NA	NA
SW093	X	NA	NA
GS13	X	NA	NA
SW091B	X	NA	NA
GS12	X	NA	NA
GS11	X	NA	NA
GS03	X	NA	NA
GS09	X	NA	NA
GS10	X	NA	NA
GS103	DRY	NA	NA
SW022	DRY	NA	NA
#1	DRY	NA	NA
#2	X	NA	NA
#3	DRY	NA	NA
Sediment Control SW107	NA	X	X
Sediment Control SW127	NA	X	NTO

NOTES

(1) NA = Not applicable These locations were not tested due to historic non toxicity

(2) NA = Not Applicable These locations were not tested for sediment toxicity

(3) NTO = No test organisms An adaquate supply of Chironomids was not available

each replicate for each dilution Again, a control is run with reconstituted water in four replicates The SeaCrest Group performed the 48-hour test using *Ceriodaphnia dubia* and the 96-hour test using *Pimephales promelas* The results were reported as the Lethal Concentration 50 (LC_{50}) LC_{50} is the percent solution resulting in 50% death of the test population versus the control blank

SeaCrest performed the chronic sediment toxicity tests on *Hyalella azteca* in 28 day exposures and on *Chironomus tentans* (Chironomids) in 10 day exposures ASTM Method E1383-90 described by Nelson et al (1990) was used The parameters measured, survival and growth, were compared to a sand control to determine significance of results

The SeaCrest Group was not able to acquire enough *Chironomus tentans* from suppliers to run all of the sediment samples for OU6 The locations successfully tested included SW107, and A-3, A-4, B-3, B-4, and B-5 Ponds

A large suite of organic, metal, and radionuclide data was gathered on the sediment samples The analytes examined included 55 organics, 26 metals, and 10 radionuclides

RESULTS AND DISCUSSION

Water Toxicity

Water toxicity tests for A-3 and A-4 Ponds were not performed because of an historic record of no toxicity (Table 3) A-5 Pond (Walnut Creek at Indiana) was not tested because its source water is A-4 Pond In 1991 and 1993, WET screens for the remaining ponds were run as a part of the OU2 and OU6 characterization and resulted in no toxicity except for B-3, B-4, and B-5 Ponds B-3, B-4, and B-5 Pond samples exhibited moderate toxicity (Table 2)(SeaCrest 1991 and 1993)

These ponds receive STP effluent where ammonia levels are typically high In these samples, total ammonia ranged from 11-30 mg/L Unionized ammonia (NH_3) has been demonstrated to be the principle toxic form, not the ammonium ion (NH_4^+) (EPA 1986)

Unionized ammonia in these samples, based on pH and test temperature, ranged from 0 3-2 6 mg/L The EPA Quality Criteria for Water (1986) lists unionized ammonia acute toxicity to 29 fish species from 0 08 to 4 6 mg/L For 19 invertebrate species, acute toxicity ranged from 0 53 to 22 8 mg/L SeaCrest reports that acute effects occur for *Ceriodaphnia dubia* at 0 86 and *Pimephales promelas* at 0 3 to 0 5 mg/L (Fucik 1993) Total ammonia and toxicity decrease downstream from B-3 to B-5 due to the natural nitrification/denitrification process

Water toxicity was again tested for the OU6 characterization using the dilution series on B-3 and B-4 in April 1993 due to toxic results in the screen tests These tests resulted in no measurable toxicity (Table 2) Further B-5 Pond WET dilutions were not performed because of an abundance of historic dilution test results (Table 3)

The base flow toxicity tests were conducted in April and May of 1993 These sites include all locations listed in Table 1 excluding the ponds For this investigation, the term baseflow is operationally defined to be a hydrologic condition where a single precipitation event is not occurring During sampling, four of fifteen locations were dry (Table 2) At all other sample sites the LC_{50}s were greater than 100% which indicates no measurable toxicity

Storm flow samples were to be taken as splits with the chemistry on May 17, 1993, but due to a miscommunication, the toxicity samples were not taken

Sediment Toxicity

Table 4 provides the results of the chronic sediment toxicity tests performed by SeaCrest Labs (SeaCrest 1993) Of the samples tested, only two showed a significantly lower survival rate than the sand controls performed in conjunction with the samples Site SW107 had *H azteca* survival rate statistically lower than the sand control SW107 and SW127 were chosen to represent

Rocky Flats Plant
FY 1994 Work Breakdown Structure (WBS) Dictionary

WBS ELEMENT

PROGRAM: A **TITLE: Environmental Restoration**

SUBPROGRAM: AA **TITLE: Remedial Actions**

COST ACCOUNT: AA06 **TITLE: OU#6 Walnut Creek**

ELEMENT SCOPE OF WORK:

Technical Content: OU6 Remediation will include assessment and remediation of the following Individual Hazardous Substance Sites (IHSS): 141, 142.1 - 142.12, 143, 156.2, 165, 166.1, 166.2, 166.3, 167.1, 167.2, 167.3, and 216.2:

Remedial Investigation Assessment

- **Work Plan Development**
- **Field Work**
- **Sample Analysis and Validation**
- **Nature and Extent Determination**
- **Baseline Risk Assessment**
  - **Human Health Risk Assessment (HHRA)**
  - **Environmental Evaluation (EE)**
- **Draft and Final RCRA Facility Investigation/Remedial Investigation (RFI/RI) Report**

Feasibility Study
Interim Remedial Action
Record of Decision
Interim and Final Remedial Action

- **Remedial Action Plan**
- **Remedial Design**
- **Remedial Construction**
- **Operation and Maintenance**

Table 4 Sediment toxicity results summary for OU6 (Compiled from SeaCrest 1993)

RFP Sampling Site	Sampling Date	Contractor Location Code	Sample Number	Toxicity to Hyalella (%Surviving)	Survival Statistically Different Than Control	Toxicity to Hyalella (Ave Weight in mg)	Weight Statistically Different Than Control	Toxicity to Chironomids (%Surviving)	Survival Statistically Different Than Control
Sand Control	11/4/92	NA	NA	89	NA	0 13	NA	82	NA
Sand Control	11/18/92	NA	NA	74	NA	0 06	NA		
RFP Control	11/4/92	SW107	SEDREF	41	Yes	0 09	No	65	No
RFP Control	11/5/92	SW127	SD50012	85	No	0 06	No		
Sand Control	11/4/92	NA	NA	89	NA	0 13	NA	82	NA
Sand Control	11/18/92	NA	NA	74	NA	0 06	NA		
Sand Control	12/4/92	NA	NA	38	NA	0 06	NA		
Sand Control	11/25/92	NA	NA	85	NA	0 05	NA		
A-1	10/29/92	SED60392	SD60003	95	No	0 11	No		
A-2	11/12/92	SED60892	SD60008	89	No	0 15	No		
A-3	10/21/92	SED61392	SD60013	76	No	0 1	No	103	No
A-4	10/19/92	SED61892	SD60018	99	No	0 17	No	73	No
A-5	11/19/92	SED64892	SD60048	89	No	0 33	No		
B-1	11/16/92	SED62392	SD60023	91	No	0 16	No		
B-2	11/18/92	SED62892	SD60028	64	Yes	0 14	No		
B-3	10/27/92	SED63392	SD60033	84	No	0 11	No	88	No
B-4	10/22/92	SED63892	SD60038	91	No	0 19	No	62	No
B-5	10/20/92	SED64392	SD60043	60	No	0 12	No	72	No

Availability of Chironomids and sample holding time limits resulted in inability to perform toxicity tests on this organism for the listed samples
NA=Not applicable
Microtox Test was not performed on this sample

background levels of sediment toxicity found outside the influence of the RFP discharges SW107 is along the western most boundary of RFP on Woman Creek (Figure 1)

SW107 was sampled because it is out of the direct influence of Rocky Flats yet is within the plant boundary However, it is not out of the influence of human activities from offsite and may have been impacted from activities along Colorado Highway 93 or cattle ranching up-gradient Sampling error may also be responsible Furthermore, this site is different from pond sites in that it is at the head of a drainage which contains water from groundwater seeps The water is known to be lower in hardness than RFP pond water The chemical characteristics of this water are, likewise, different than RFP pond water in that it typically has lower concentrations of metals, organics, and less buffering capacity However, SW127 which is directly south of SW107 showed no toxicity to *H azteca* This sediment should have been very similar to SW107's

The other site with a significantly lower survival rate for *Hyalella* versus the control was pond B-2 The overall survival was 51 out of 80 organisms Chemical data on the pond sediments is available to compare with toxicity findings However, '[t]o assess the importance of types of in-place pollutants one must know more than how much of each chemical exists in the sediment It is necessary to know the forms in which the chemicals exist and how available they are to benthic organisms or to be transported (sic) in the water column" (de Bernardi 1990)

To assess the apparent sediment toxicity in pond B-2, only the <u>total concentrations</u> of sediment associated radionuclides, metals, and organics are known The speciation or availability of each within the sediment is unknown So, for a first approach to determine a potential toxin or group of toxins causing B-2 toxicity, the total levels of sediment associated chemicals in B-2 Pond were compared with the levels found in several nontoxic ponds at RFP This assumes that the fraction of the total value which is actually biologically available is the same in each pond, so their total values can be compared

B-1 and B-3 Ponds were chosen as the nontoxic comparisons to B 2 since they showed no significant toxicity to *Hyalella* B-1 and B-3 Ponds are assumed to be very similar to B-2 since they are located approximately 100 yards from B-2 are within the same watershed and have similar geology However, B-1 and B-2 are fed only by direct run-off, groundwater infiltration, and precipitation, while B-3 receives effluent from the RFP STP Table 5 illustrates a comparison of the various sediment associated chemicals within each pond

In examining the concentration of each toxic metal among the ponds, several are higher in B-2 than in B-1 (Table 5) All of the metals except arsenic were at lower concentrations in B-2 sediment than B-3 sediment However, nontoxic sediment from B-4 Pond had higher concentrations of arsenic than B-2 sediment Also, summing the concentrations of the toxic metals in each pond sediment, B-2 Pond sediments were lower in total toxic metals than all other B-series ponds Hence, the sediment toxicity in B-2 is probably not due to metal concentrations

Pond sediments were analyzed for ten anthropogenic and natural radionuclides Also, gross alpha and beta radiation was measured Of the radionuclides measured, cesium-137, radium-226, and strontium-89,90 were higher in B-2 sediments than B-1 sediments (Table 5) Gross alpha and beta measurements of the sediment sample from B-2 were lower than the B-1 sample Hence, radiation is probably not the cause of toxicity in B-2 sediments

From comparison of the pond sediments, it is apparent that B-2 is not similar to other ponds in the concentration of organics in its sediments This is an indication that organic compounds may be the source of toxicity in B-2 Pond Many of the organics were labeled as unknowns, in that they were not identified by the laboratory performing the analysis and were simply reported as an unknown at a particular concentration Therefore, from the available data and lack of definitive identification of many of the detected organics, the contaminant(s) of concern are not obvious

Two other observations are noteworthy An estimated 2 gallons of diesel fuel were spilled into B-2 in 1992 from a diesel powered transfer pump At least a few of the unknown organics found in B-2 were hydrocarbons Also, SeaCrest noted that the DO of this sample was among the lowest

Table 5 Comparison of chemical constituents found in B 1 B 2 and B 3 Pond sediments

Location Comparison	Concentration Individual Toxic Metals	Concentration Total Toxic Metals	Concentration Individual Radionuclides	Gross Alpha Radiation	Gross Beta Radiation	Concentration Individual Organics	Concentration Total Organics
B 1 vs B 2	B 2 > in Ag Hg Cs As	B 1>B 2	B 2 > in Ra 226 Cs 137 Sr 89 90	B 1>B 2 by 410 3 pCi/g	B 1>B 2 by 17 12 pCi/g	B 2>B 1 for19 (15 were Unknowns)	B 2>B 1
B 3 vs B 2	B 2 > in As	B 3>B 2	B 2 > in U 233 234 Ra 226	B 3>B 2 by 33 1 pCi/g	B 3<B 2 by 2 91 pCi/g	B 2>B 3 for 27 (20 were Unknowns)	B 2>B 3

measured in the suite of samples tested (<1 0) (SeaCrest 1993) However, B-3 Pond had a comparably low DO, but was not significantly toxic

It is noteable that B-5 Pond had a lower overall survival than B-2 in the four replicate tests (48 out of 80 organisms, 20 organisms run per replicate test) However, the B-5 test had a large variance and standard deviation between replicates (Table 6) Statistical comparison (Dunnetts Test) of B-5 results to the sand control showed the differences in survival were not significant

None of the samples tested showed average *H azteca* weights significantly lower than the controls for that test

Survival of Chironomids was not statistically different in the samples versus their sand control SeaCrest noted the abundance of naturally occurring Chironomids in many of the samples (SeaCrest 1993)

CONCLUSIONS

Water toxicity tests for the pond and drainage sampling sites resulted in acute toxicity to *Ceriodaphnia dubia* and *Pimephales promelas* for three locations B-3, B-4, and B-5 Unionized ammonia was at toxic levels for these samples The second testing of B-3 and B-4 Ponds resulted in no toxicity There is an abundance of historic data for B-5 with periodically high unionized ammonia concentration

One pond in OU6 resulted in measurable sediment toxicity B-2 sediments were toxic to *Hyalella azteca* The *Hyalella sp* survival rate was significantly lower than the sand controls performed in conjunction with the samples The distribution of toxicity, as well as chemical contamination in B-2 Pond, should be examined in detail Though it appears upon first analysis that organic compounds are the prime interest for understanding toxicity in B-2, other categories of contaminants must not be ruled out Thorough analysis of the "unknown" organics in B-2 sediments is required Careful data analysis and literature studies should help illuminate the availability of sediment-associated chemicals in B-2 sediments

Table 6 Statistical analysis of Hyalella survival in B 5 Pond SW107 and B 2 Pond

Location	Hyalella Survival Replicate 1 (out of 20)	Hyalella Survival Replicate 2 (out of 20)	Hyalella Survival Replicate 3 (out of 20)	Hyalella Survival Replicate 4 (out of 20)	Total Hyalella Survival (out of 80)	Standard Deviation	Variance	Dunnett Table Value 1 tailed P=0 05	T Statistic	Significant Difference
Sand Control For B 5 and SW107 tests	16	17	18	20	71	1 708	2 917	2 46 (df=20 6)	NA	NA
B 5	10	18	13	7	48	4 69	22	2 46 (df=20 6)	2 233	No
SW107	15	12	5	1	33	6 397	40 917	2 46 (df=20 6)	3 689	Yes
Sand Control for B 2 Test	19	16	14	19	68	2 449	6	2 18 (df=9 2)	NA	NA
B 2	14	13	12	12	51	0 957	0 917	2 18 (df=9 2)	3 72	Yes

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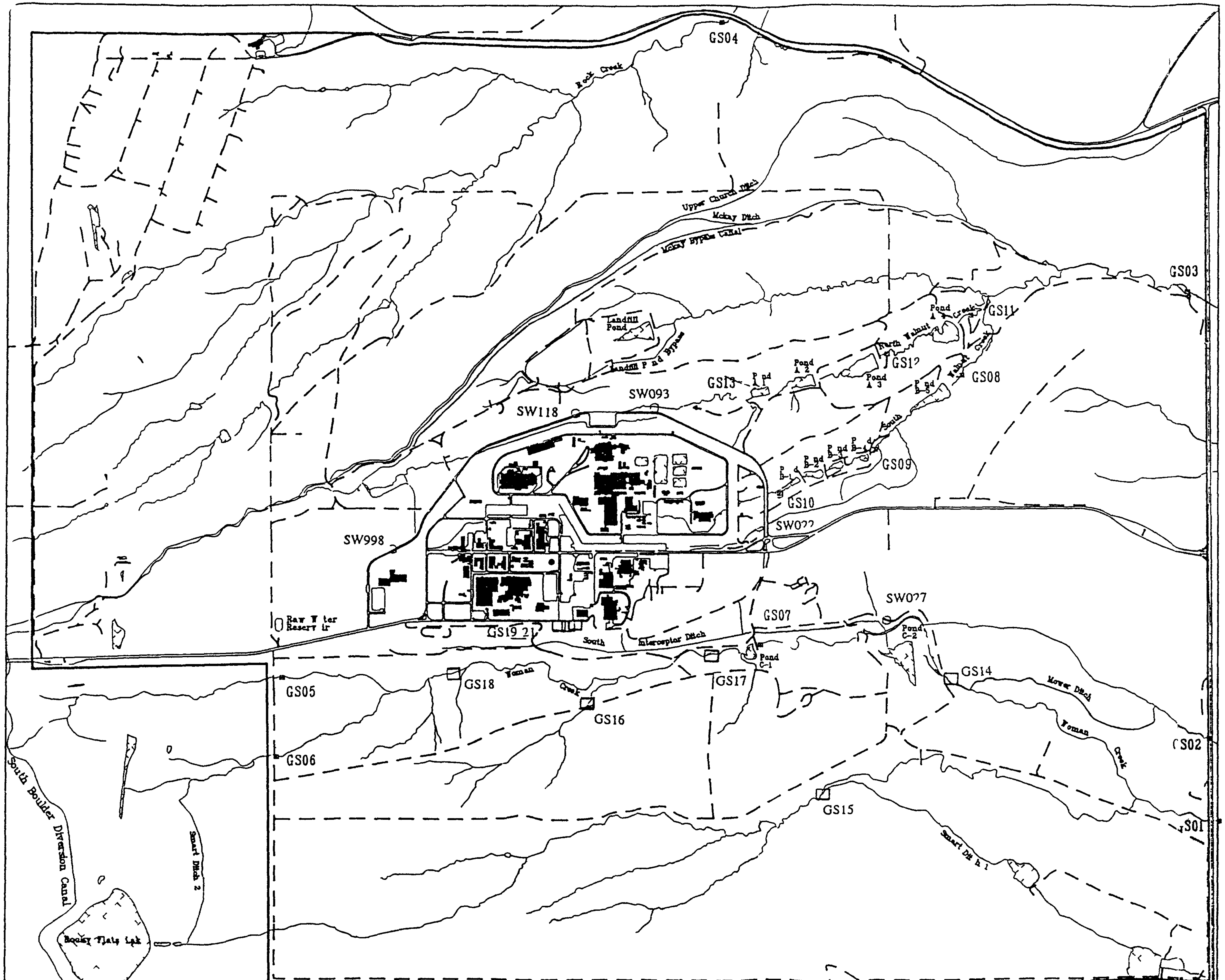
Table 3 Summary of NPDES biomonitoring data applicable to OU6 from 1989 to present (a)

	STP EFFLUENT			B-5 TRANSFER			A-4 DISCHARGE		
DATE	Ceriodaphnia LC50	Fathead LC50	Total Ammonia mg/L	Ceriodaphnia LC50	Fathead LC50	Total Ammonia mg/L	Ceriodaphnia LC50	Fathead LC50	Total Ammonia mg/L
1989									
April									
June									
September	100	100	12 9						
1990									
January									
Changed from quarterly to monthly sampling									
March							100	100	0
April							100	100	0
May							100	100	0
June	100	73 4	28 3						
July									
August									
September	100	33 7	50 (b)				100	100	0
October	88 2	41 6	26				100	100	0
November	100	100	22				100	100	0
December	60	52 3							
1991									
January	41 2	18 5	45				100	100	0
February	100	100	27				100	100	5 7
March	100	100	21				100	100	11
April	94 5	64 2	41				100	100	5 6
May	100	95 5	33 8	100[100]	83 9[100]	9[8 5]	100	100	5 7
June	100	100	33	100[100]	100[100]	4 5	100	100	2 3
July	75 8	47 5	29 3	100[100]	100[100]	7 6[7 6]			
August	100	100	26	100	100	6 6	100	100	3 2
September	100(100)	100(100)	14 9(4 7)	100[100]	100[100]	10 3[11 2]	100	100	2 9
October	100(100)	100(100)	22 8(12 8)				100	100	1 7
November	100(100)	100(100)	3 6(0)	100	100	13 3			
December	100	86 6	29 3	100	100	12 1	100	100	6 6
1992									
January	100(100)	78 5(100)	32 4(5 8)	100	100	12 1	100	100	6 6
February	100(100)	100(100)	2(0)	100	91 5	17 8	100	100	9 7
March	100(100)	100(100)	26 9(6 4)	100	100	8 4	100	100	7 2
April	67 1(100)	79 4(100)	22(1 8)	100	100	6 6	100	100	3 8
May	100(100)	41 9(100)	39 2(6 0)	100	100	8 9	100	100	3 3
Discontinued in pond sampling									
June	100	(g)	27 9	100	100	10 9	100	100	2
July	83 9	100	17 9	100	100	7 1	100	100	0
August	100	100	20 8	100	100	7 5			
September	100	100	20 4	100	100	4 9	100	100	1 9
Changed from monthly to quarterly sampling									
October	100	100	17 21	100	100	9 5	100	100	2
November									
December									
1993									
January	100	83	24 3	100	100	16 8			
February							100	100	6 4
March									
April	100	100	18 3	100	100	12 2	100	100	12 1
May									
June									
July									
August									
September									
October									
November									
December									

(a) The Seacrest Group (formerly T H E Laboratories) processed these biomonitoring tests
(b) The Seacrest Group noted this value to be "suspect" "expected value is probably half this level
(c) A value in parentheses e g (100) is the EC50 after the sample was filtered through zeolite
(d) A value in braces e g [100] represents the EC50 of a second test within the stated month
(e) The October 1990 fathead EC50 for A-4 B 5 and C-2 were all unusually low and suspect
(f) Zero values for ammonia represent no detection
(g) The lab failed to set up the fathead test



U S Department of Energ, Rocky Flats Plant

Figure 1

Surface Water Sample Locations

Gaging and sampling station for storm-event monitoring

○ NPDES storm water permit sampling site

Paved roads

Unimproved dirt roads

Streams, ditches and other drainage features

Rocky Flats Plant boundary

Ponds/Lakes

Buildings or structures

now operat on

Fig 1

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Mapscale = 1 20000
1 inch = 1670 feet
0 1670 3010

Prepared by

EG&G ROCKY FLATS

Rocky Flats Plant
P O Box 464
Golden Colorado 80402-0464